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Glucocorticoid-induced changes in the geometry of osteoclast resorption cavities are sufficient to alter bone quality: an assessment through a model simulating bone stiffness

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Formål Loss of bone strength and prevention of fracture is a major concern for clinicians dealing with bone pathologies, such as postmenopausal osteoporosis and glucocorticoid-induced osteoporosis (GIO). For postmenopausal osteoporosis fracture risk is mostly defined by BMD thereby taking into account deficits in bone mass and degree of mineralization. However, in the case of GIO it is well known that BMD is a poor predictor of fracture risk. We have recently found that glucocorticoid (GC) causes osteoclasts (OCs) to change their resorptive behavior and making large elongated resorption cavities instead of individual circular resorption cavities, but without affecting the total eroded surface.
The aim is a change in resorptive behavior of OCs sufficient to increase the fracture risk in GIO.

Metode The three dimensional characteristics of resorption cavities generated in vitro by human OCs in the presence or absence of GC were recorded. These data were used to model the impact of GC-induced resorption on the mechanical properties of bone using the beam-shell finite element model of trabecular bone.

Resultater The model showed that resorption cavities generated in the presence of GC caused a statistical significant loss of stiffness as simulated for three bone sites (4^{th} lumbar spine, femoral neck and iliac crest), when compared to control. This strongly suggests that the altered resorptive behavior of the OC due to GC-exposure is sufficient to enhance the fracture risk at these sites. It is worth noting that the GC-induced changes of the shape of cavitations had the highest impact on bone stiffness in the 4^{th} lumbar spine. It is therefore interesting to note that GIO is in particular associated to an increased risk of vertebral fractures.

Konklusion Changes in the shape of OC resorption cavities are sufficient to reduce bone stiffness/strength independent of the extent of eroded surface. This shows the general need of taking the quality of OC bone resorption into account and not only broad quantitative measurements of OC activity as usually done through histomorphometry or bone markers.